The Submillimeter And Far Infrared Experiment (SAFIRE)

A PI Class Instrument for SOFIA

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SAFIRE is a versatile imaging Fabry-Perot spectrograph covering 145 < l <655μm, with spectral resolving powers ranging over 5-10,000. Selected as a "PI" instrument for the airborne Stratospheric Observatory for Infrared Astronomy (SOFIA), SAFIRE will apply two dimensional pop-up bolometer arrays to provide background limited imaging spectrometry.

SAFIRE is expected to be a "First Light" instrument, useable during the initial SOFIA operations. Although a PI instrument, rather than a "Facility" class Science Instrument, it will be highly integrated with the standard SOFIA planning, observation, and data analysis tools. Collaborators and other users of SAFIRE are actively sought. Interested observers are encouraged to register with the SAFIRE observer mail list at: http://pioneer.gsfc.nasa.gov/public/safire/

Design Elements

The initial configuration of the instrument (Phase I) has only a single spectrometer with a 6x32 semiconductor bolometer array. Later augmentations will upgrade the array to a larger size (Phase II) and the addition of a second array and optics supporting lower resolution and grating based spectroscopy (Phase III).

Phase I:
- A high resolution (R=1,000 to 10,000) imaging Fabry-Perot (HRFPI),
- Broad band filters,
- Internal calibration reference sources,
- 6x32 array of semiconductor bolometers, packed using Pop-Up Bolometer (PUB) technology,
- R=100 sensitivity better than 30 mJy for a single 10,000 second observation,
- 1 mm pixels = 10.6" provide better than Nyquist sampling of the diffraction disk over the entire spectral band.

Phase II:
- Replacement 32x32 array of Transition Edge Sensor (TES) bolometers,
- SQUID amplifier and multiplexing circuitry (low noise, reduced thermal isolation problems and dewar wire count).

Phase III:
- A second 32x32 TES array and SQUID amplifier/multiplexing circuitry
- Low resolution (R=100) imaging Fabry-Perot (LRFPI)
- Slit plus grating (R=100) non-imaging spectroscopy

Science

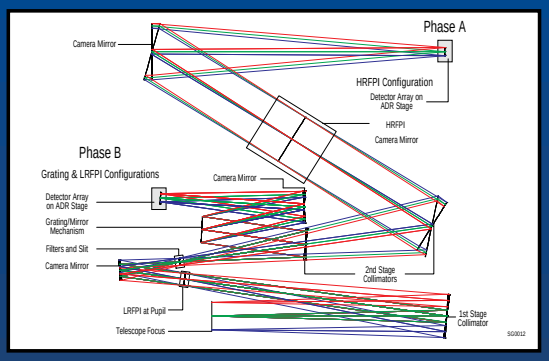
The primary goal of SAFIRE is to explore the physical conditions and astrophysical processes in a variety of astrophysical environments using a large number of lines in the 145 - 655 micrometer wavelength regime from key molecular, ionic, and atomic species as well as gas and dust continuum emission. Specifically:
- [O I] (145μm) and [C II] (158μm), dominant coolants of warm neutral media;
- CO, HCN, H_20, O_2 transitions to probe central regions of molecular clouds;
- [NII] (205μm) to trace and constrain warm ionized gas;
- [CI] Molecular cloud interface and PDR physics.

Particular disciplines:

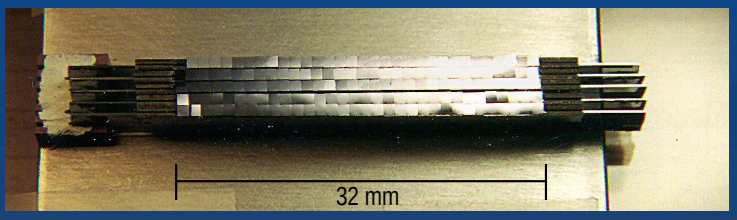
Star Formation and Evolution –
- A multi-phase probe of star forming regions and ISM,
- Proto-stellar Outflows – shock excited line and continuum emission,
- Photo-dissociation regions and interaction with molecular clouds,
- Post Main Sequence mass loss – spatial distribution of dust formation in nearby stars,
- Star formation in nearby galaxies
- Correlation with ISO and SIRTF observations
- Magellanic Clouds – Test low-metallicity PDR models,
- Star Formation in AGNs and other active galaxies, including the AGN molecular torus,
- The Galactic Center as a nearby prototype for AGN and starburst behavior

Cooling Flows in Clusters of Galaxies –
- Determine the fate of the infalling gas,
- Evaluate if cooling flow physics provides a template for star formation in the early universe,
- Spatially resolve low temperature component of cooling flow,

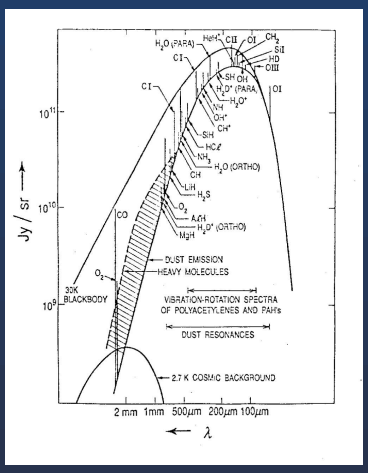
Planetary Physics –
- Imaging Spectroscopy of Circumstellar Disks,
- Composition and Atmospheric Physics of Solar system objects
  - Titan (complement and pathfinder for Cassini)
  - Uranus
  - Neptune



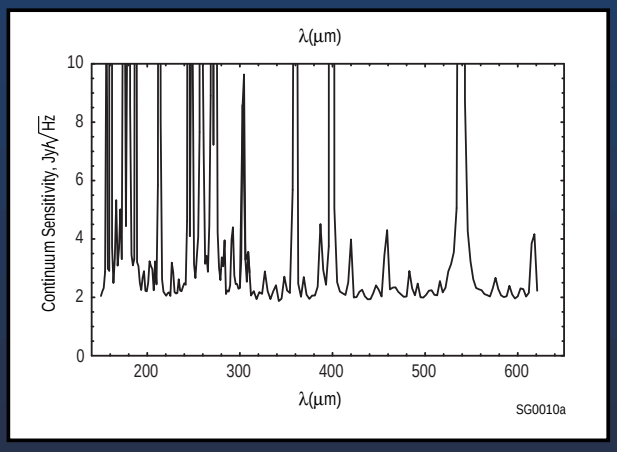
Optical Block Diagram from the telescope focus to the detector arrays. The diagram shows the optics associated with the initial configuration of a single detector and the HRFPI (Phase I/II) as well as the second detector array, the LRFPI, and grating of the Phase III extension.



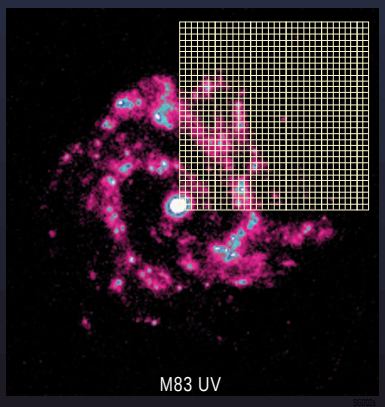
Test assembly of a 5x32 element array using a flight-like PUB mechanical model, identical in geometry to the SAFIRE detectors.



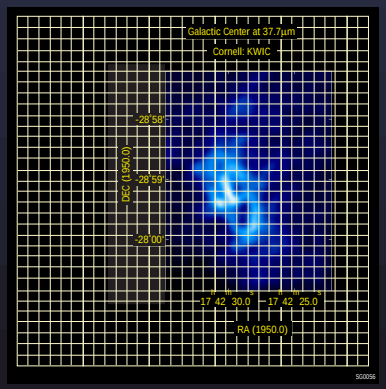
A schematic presentation of some lines in the submillimeter and FIR bands, expected in the spectrum of molecular clouds (Phillips & Keene 1992).



SAFIRE predicted performance on SOFIA with a resolving power of 100.



UIT ultraviolet picture of a star forming galaxy show that SAFIRE is well suited to mapping nearby galaxies. The grid shows the Phase II/III 32x32 detectors' field of view.



SAFIRE's large field of view (the white grid is the Phase II/III 32x32 pixel detector) allows rapid mapping of the entire Galactic Center region in a wide range of spectral lines.

Schedule / Operation

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